the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Measurements of ^{222}Rn, ^{220}Rn, and CO_2 Emissions in Natural CO_2 Fields in Wyoming: Monitoring, Verification, and Accounting Techniques for Determining Gas Transport and Caprock Integrity

Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide (CO_2). Carbon capture and storage (CCS) technologies offer great potential for reducing CO_2 emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO_2 storage; and CO_2 capture.

Project Description

NETL is partnering with the University of Wyoming (UW) to conduct a systematic survey of discrete radon (Rn) and CO_2 flux measurements in soil gases at field sites in Wyoming where previous work has demonstrated geologic correspondence of moderate to high gamma background radiation (i.e., potential Rn degassing) with naturally-occurring CO_2 (Figure 1). Natural CO_2 analogues provide a means of understanding and predicting behavior in geologic storage reservoirs, particularly as test beds for investigating and improving technologies and protocols aimed at assessing the integrity of caprock formations. Radon is a noble gas and the only naturally occurring radioactive gas. It has two isotopes, ^{222}Rn and ^{220}Rn, both of which are relevant to this project. ^{222}Rn is a short-lived decay product derived from the ^{238}U (Uranium) decay series, with a half-life of 3.82 days. ^{220}Rn is a decay product derived from the ^{232}Th (Thorium) decay series and has an even shorter half-life

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

William Aljoe
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-6569
william.aljoe@netl.doe.gov

John Kaszuba
Principal Investigator
University of Wyoming
1000 E. University Avenue
Dept 335
Laramie, WY 82071-2000
307-766-6065
john.kaszuba@uwyo.edu

PARTNERS

None

U.S. DEPARTMENT OF ENERGY

PROJECT DURATION

Start Date

12/01/2009

End Date

11/30/2012

COST

Total Project Value

$299,768

DOE/Non-DOE Share

$299,768/$0

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

(56 seconds) that makes it useful in identifying areas of very fast soil-gas transport. Elevated Rn emissions are strongly correlated with high CO_2 emissions in volcanic systems; thus, ^{222}Rn provides a means to identify deep CO_2 flow in geologic storage projects, and map active, high porosity regions prone to CO_2 movement. This proposed Rn-CO_2 relationship will be tested to determine if discrete radon and CO_2 fluxes could be used to indicate potential leakage in CCS projects.

Since chemical reactions affect the distribution of nuclides within the ^{238}U and ^{232}Th decay series (i.e., U-series), UW will replicate field conditions in a laboratory setting in order to evaluate the effects of mixed phase CO_2-H_2O-rock reactions on subsequent Rn degassing. Measuring CO_2 and both isotopes of Rn from the same samples will constrain the relationship between Rn degassing and CO_2 flux. The different half-lives provide important constraints on the source/depth of the Rn since ^{220}Rn—because of its extremely short half-life (56 seconds)—will decay over long transport times. Because of its short half-life, ^{222}Rn possesses the unique advantage of being used to estimate the timescale of CO_2 migration. However, because the main source of the measured Rn (shallow soil degassing, deep reservoir degassing, or both) is undetermined, the nature and relevance of the temporal constraints from ^{222}Rn remain uncertain.

Goals/Objectives

The goal of the project is to determine whether quantitative measurement techniques for Rn activity and CO_2 flux that have already been established for natural volcanic systems, can be applied to natural and laboratory CO_2 analogues as a means of assessing caprock (seal) integrity and potential CO_2 leakage for geologic storage projects. This project will provide training opportunities for two graduate students and one undergraduate student in geologic and geochemical skills required for implementing and deploying CCS technologies.

Benefits

Overall the project will make a vital contribution to the scientific, technical, and institutional knowledge base necessary to establish frameworks for the development of commercial-scale CCS. By applying the geologic principles of field measurements at natural CO_2 analogues in Wyoming with the geochemical principles of ^{222}Rn, ^{220}Rn, and CO_2 measurements in laboratory and field settings, UW can evaluate and calibrate the use of naturally occurring Rn isotopes for evaluating the reliability of caprock formations. Instruments and techniques to analyze Rn and CO_2 have already been developed for other industrial applications and can easily be deployed for sequestration leak detection and caprock integrity assessment. This work will increase the geologic sequestration knowledge base and continue to move CCS research towards more applied technologies.

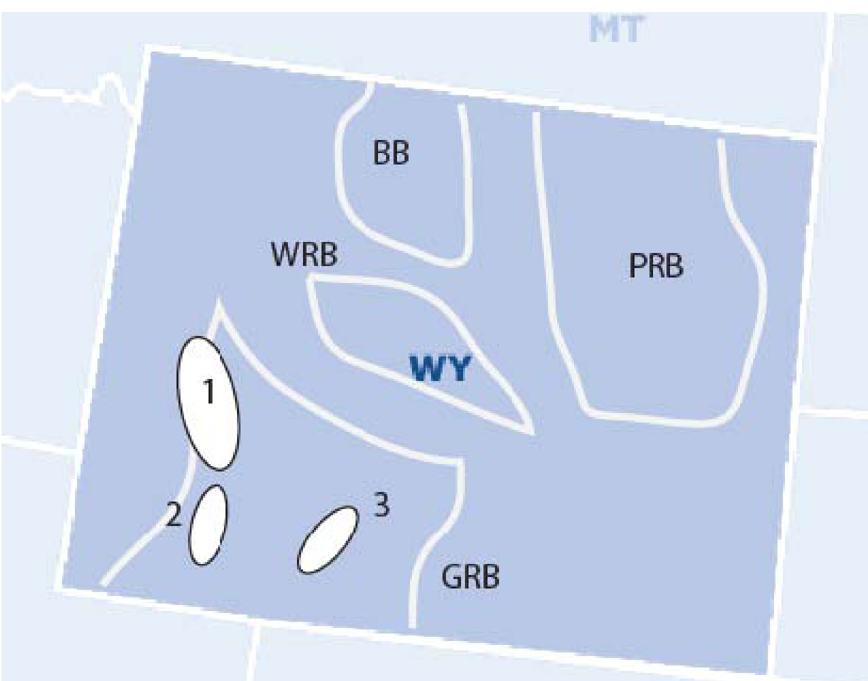

Figure 1. Location of natural CO_2 analogues in Wyoming that coincide with background gamma radiation anomalies (1 = La Barge; 2 = Bruff, Church Buttes, and Butcher Knife Springs; 3 = Brady). Schematic outlines of major Wyoming basins are also shown (BB = Bighorn Basin; PRB = Powder River Basin; WRB = Wind River Basin; GRB = Greater Green River Basin). Adapted from De Bruin (1991), Cannia and Case (1986), and De Bruin et al. (2004)